THE MURIDS AND SMALL DASYURIDS IN TASMANIA

Parts 1 and 2

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Part 1. INTRODUCTION

Except for the water rat (*Hydromys chrysogaster*), a commercial fur-bearer, and the three exotic murids which are subject to pest control operations, the murids and smaller dasyurids of Tasmania have not been directly affected by human interference as have the larger mammals. However, the drainage and clearing of river flats, tea-tree swamps and other areas of suitable habitat has undoubtedly affected their status.

Little research had been undertaken on these animals in Tasmania until recently. In the autumn of 1963 an investigation was commenced by the author into the distribution, status and life histories of the murids and small dasyurids. As various rodents and small dasyurids are found in similar habitats and are taken indiscriminately in traps, it was thought desirable and convenient to study them all at the same time.

As it is intended to publish results of the investigations as data accumulate it was thought advisable to review the information available on the Tasmanian forms at the commencement of the study. Numerous endemic species of Muridae and *Antechinus* are described in the older literature but most of these have been relegated to synonymy. (See Iredale and Troughton 1934).

Today only seven species of Muridae are recognized in Tasmania, including three exotics. An additional species is recorded from fragmentary sub-fossil remains of the lower jaw and associated incisors (J. A. Mahoney, personal communication). One species is endemic and two differ subspecifically from their mainland relatives.

Guiler (1958) reported the capture of a specimen of *Rattus* and stated that it probably belonged to the *assimilis* group. No other investigator has recorded rats of *assimilis* type in Tasmania and Guiler's determination is surely an error. He (Guiler 1959) has also reported the occurrence in Tasmania of *Ascopharynx cervinus* (Gould) (=*Notomys cervinus*), a species normally found in the desert areas of South Australia. This record has been discussed by Sharland (1962) who suggests that the specimens in question were introduced from mainland Australia and subsequently escaped or were released. The present author agrees with Sharland.

Two species of *Antechinus* occur and both of these have been shown to be subspecifically distinct from their mainland representatives. One species of *Sminthopsis*, which occurs also on the mainland, is found in Tasmania.

RODENTIA : MURIDAE

Hydromys chrysogaster Geoffroy

This indigenous species is Tasmania's only true water rat. It is widely distributed with a habitat range extending throughout the entire drainage system from highland lakes to tidal rivers, ocean beaches and rocky seashores.

It hides by day beneath any cover which will afford seclusion and becomes active at dusk. Its food consists of a wide variety of organisms, including molluscs, crustaceans, fish and a certain amount of vegetable matter (Lord and Scott 1924). It is a notorious scavenger and the angler risks losing his catch if he leaves it unattended near the water's edge after sunset. It causes considerable damage to bundled fishing nets in its efforts to secure edible remains of the catch.

The water rat is only partly-protected and can be taken under licence annually between 1st May and 31st July. The pelts are of commercial value because of the quality of the fur, but the number sold are of little importance to the maintenance of the species or economically.

Rattus lutreolus velutinus (Thomas)

The velvet-furred rat, Tasmania's most common indigenous species, occurs in a wide range of habitats from coastal swamp-land to sub-alpine rain forest. Variations in colour and size resulted in its being described several times as different species (Higgins and Petterd 1883; 1884 *a*, *b* and *c*).

As recently as 1934 it was still thought that two closely-related native species of *Rattus* occurred in Tasmania (Iredale and Troughton 1934), but today these are considered to be synonymous, and only one form is recognized which is considered subspecifically distinct from the mainland one (Troughton 1965).

Rattus rattus (Linnaeus)

The black rat was accidentally introduced to Tasmania with early settlement and subsequently became widely established as a bush and house-dwelling animal. Its spread was no doubt greatly assisted by the settlers and miners. As these pioneers penetrated more deeply into the uninhabitated parts of the state to establish farms and mining ventures, so the rodents followed and capitalized on the new environment and food supply provided by man. However, the fact that it was collected in seemingly unaltered bushland, together with its considerable variability in colour confused some early naturalists and resulted in its being described under a number of different specific names as endemic Tasmanian rodents (Higgins and Petterd 1883; 1884 *a*, *b* and *c*). Even Oldfield Thomas accepted some of these as valid species for a time. As more material became available the mistaken determinations were corrected (Lord and Scott 1924).

This rat occurs most commonly in association with human settlement and seeks the shelter of man-made constructions. It is a competent burrower and will excavate beneath foundations or in the banks of streams, at times creating quite complicated burrow systems.

Its numbers in rural areas have occasionally reached plague proportions, such occurrences usually being local and influenced by an abundant food supply such as grain. Because of modern harvesting methods and the introduction of highly-improved poisons, it rarely becomes more than a minor pest.

It is highly predacious and is capable of taking birds in excess of its own size. I have personally seen rats kill domestic chickens twice their own weight by seizing the birds by the head and retaining hold despite their violent efforts to free themselves. Whenever possible, victims are dragged away from the site of the kill to be consumed in some secluded corner. It feeds on a wide range of animal and vegetable foods and is an excellent swimmer on or beneath the surface.

The black rat is declared vermin under Tasmanian state law.

Rattus norvegicus (Berkenhout)

The brown rat was accidentally introduced to Tasmania during the early years of settlement, and has for many years been a pest in suburban and built-up areas and occasionally around farms. It seldom becomes established in bush communities but its preferred habitat is the environment of sewerage systems, warehouses, wharf areas, city rubbish tips etc. where it can usually find a plentiful food supply. Despite modern methods of control it remains an important pest of concern to public authorities, produce merchants, and warehouse tenants.

Its fur is usually grey but occasionally half-white animals are found. It can attain a body weight in excess of 300 grams: such large individuals being almost equal in size to the native Water Rat (*Hydromys*). It has a predatory disposition and will take chickens or ducklings of weights in excess of its own. It is an excellent swimmer on or beneath the surface. It is declared vermin under Tasmanian state law.

Mus musculus (Linnaeus)

Introduced accidentally to Tasmania by the early settlers, the European house mouse rapidly spread and became established in houses and other buildings and in fields. No doubt its spread was greatly assisted by the transport of oaten chaff. It could safely remain inside bags of this fodder which were carted in quantity and used to feed horses, the principal means of locomotive power in the early days. Likewise stacks of oaten hay, often held for months before being cut into chaff, provided ideal shelter and an ample supply of food which promoted extensive breeding resulting in local population explosions.

In 1882 it occurred in numbers in the Ringarooma district of north-eastern Tasmania. Specimens were collected by Mr. A. Simson and forwarded to Messrs. Higgins and Petterd who described it as a new endemic rodent *Mus simsoni* (Higgins and Petterd 1883), apparently being completely deceived by its ability to thrive under Tasmanian field conditions.

With the replacement of the horse by the motorised vehicle and the resultant decrease in the number of stacks of oaten hay, the field population of *M. musculus* has been greatly reduced. Its occurrence today is usually restricted numerically, presumably because of the limited availability of suitable food. It is well adapted to a wide range of habitats and can be taken in relatively unaltered bush where it is not in any way dependent on man-made alterations to the environment.

Pseudomys higginsi (Trouessart)

The long-tailed rat is an endemic Tasmanian species occurring in the myrtle rain-forest and wet sclerophyll forest.

A number of specimens were collected in the Waratah area by O. L. Adams and others towards the end of the nineteenth century and Finlayson (1933) found it plentiful in the beech and pine scrubs in Cradle Valley in 1931.

Mastacomys fuscus Thomas

A rare and localised rat, the broad-toothed rat was originally described by Thomas (1882) from a single Tasmanian specimen. In 1931, Finlayson (1933) collected five specimens from Cradle Valley, north-west Tasmania, and thereby established the fact that it was still in existence. He amplified Thomas's original description.

The Tasmanian Museum holds two spirit specimens (ZC41) collected at Port Davey, south-west Tasmania in 1950. Both this area and Cradle Valley carry a primitive Button Grass (*Mesomelaena sphaerocephala*) type of habitat to which this rat appears to be mostly confined. Its presence in sub-fossil cave deposits suggests that it was far more plentiful during former times when its preferred habitat was presumably more extensive and unaffected by man. It does not appear to have been able to adapt itself to the changing environment.

Though it has since been recorded from mainland localities (see Calaby and Wimbush 1964) it is nowhere plentiful, and has been recognized as one of the Australian mammals, the survival of which is threatened (Calaby 1963).

MARSUPIALIA : DASYURIDAE

Antechinus minimus minimus (Geoffroy)

The little marsupial-mouse is a rare and apparently localised animal which was afforded subspecific status by Wakefield and Warneke (1963) when they showed that a different race occurred on the mainland. The Queen Victoria Museum has two males collected at Magnet (near Waratah) in February 1904 but these are in poor condition and without skulls, and confirmation of the original determination is now difficult. Another was collected at Blue Rocks, Flinders Island in June 1961. It occurs on isolated Maatsuyker Island south of Tasmania and representative specimens from there are held in both the Queen Victoria Museum (1959:1:13) and the Tasmanian Museum. Single individuals came to hand in 1944 from Selbourne in the north and from South Mt. Cameron in the north-east of the island.

Though it has been recorded from widely ranging areas it is nowhere plentiful and occurrences indicate that it prefers the more open sedgeland habitat usually shunned by *A. swainsonii*. Additional distributional data, the type specimen, and early taxonomy of the species, are discussed by Wakefield and Warneke (1963). Three species of *Antechinus* had been described from Tasmania prior to 1882 and subsequently six more were described by Higgins and Petterd (1884). These have since been shown to be synonyms of the two species dealt with here.

Antechinus swainsonii swainsonii (Waterhouse)

Though locality records of Swainson's marsupial-mouse are few, its habitat preference indicates that it is

probably the more common of the two *Antechinus* species occurring in Tasmania. A different subspecies occurs in the south-eastern part of mainland Australia.

It was collected in the Waratah district at the end of the last century and the Queen Victoria Museum holds specimens from Kindred (1924) and Fingal (1940). Wakefield and Warneke (1963) give additional locality records, and discuss its taxonomy and synonymy.

Sminthopsis leucopus (Gray)

There are fewer records of the white-footed marsupial-mouse in Tasmania than of any other marsupial and its status is unknown. It has been recorded from a few isolated localities on the north and east coasts but recent collecting has resulted in its discovery in northern inland areas. Future investigation may yet prove it to be more common than existing records indicate.

Gyomys or *Leggadina* sp.

A quantity of sub-fossil bone material collected from the floor of a limestone cave at Flowery Gully in 1959 contained representatives of most Tasmanian terrestrial vertebrates. Amongst these were nine fragmented lower jaws, mostly with associated teeth, which have been determined by Mr. J. A. Mahoney as belonging to either one of the above genera. This is the first and only record of this rodent in Tasmania and it is believed to have died out now.

Part 2. *Rattus lutreolus velutinus* (Thomas)

ABSTRACT

The results of three years (1963 - 1965) collecting and field observations on the Velvet-furred Rat *R. l. velutinus* are recorded.

The known distribution is mapped and the various habitat preferences described.

A full description of the rat is given together with tabulated measurements of the plastic features and skull. From the degree of molar tooth wear it has been found possible to assess the approximate age of the rats. This, in turn, has shown the normal life expectancy to be a little over one year but that odd individuals will survive two years.

Notes are given on habits and the formation of runways and burrows and the selection of nest sites. The availability of food items is discussed and the specific characteristics of faecal pellets given.

Breeding has been found to be prolific and seven litters totalling 27 young have been born from one captive pair in eleven months. In the wild state, breeding is usually restricted to a summer season.

New born young are described and their rate of growth and development given. Sexing by scrotal pigmentation has been found practicable from birth. Details of trapping methods and the baits used on about 5,700 trap nights are given together with the catch results and catch expectancy.

Field studies using fingerling fish tags to individually mark rats have been in operation and the results to date have given information on range, movement, breeding aud life expectancy.

A series of parasites has been collected and some determinations of these are tabulated.

The influence of natural predation and the effect of habitat destruction is discussed.

DISTRIBUTION

Recent investigations have shown that this rat has a wider distribution than was at first anticipated. Some habitat types appear particularly favourable and are more densely populated, but it has now been found occurring in more or less significant numbers over the greater part of Tasmania (see map, figure 1). It occurs in greatest abundance in the western half of the island where much of the country lacks human settlement or influence and still remains in its natural state. Though it may once have occurred in similar density in the eastern half, this is not the case today as here it is generally confined to a few remaining areas still unexploited.

Its apparent absence from large areas of the midlands appears to be correlated with the grazing of sheep and cattle and the development of agricultural land. This correlation extends to the east and north coastal regions and the central plateau, where this rat may reasonably be expected to occur. It is reasonable to expect that clearing and agriculture would remove the native rodents, but there remain large areas of almost unimproved grassland and light bush which are utilized solely for grazing. At first appearance such areas seem to be a suitable environment, but except for small isolated colonies in rough or swampy places which are relatively inaccessible to stock, *R. l. velutinus* remains unrecorded. This is probably due to a combination of several factors, such as the burning of vegetation as it becomes overgrown, disturbance by the trampling of stock, and the close grazing of surface vegetation which provides necessary cover.

The distribution map shows the localities from which specimens have recently been collected. The shaded area is the present known range, based on sampling of habitat types. Amongst the collections of the National Museum, Melbourne, is a skin and skull (Reg. No. R5447) from King Island, Bass Strait, December 18, 1887. The extensive agricultural development of the island may have since annihilated the population. *R. lutreolus* has recently been collected on Flinders Island by Miss Jeanette Partridge (pers. comm.)

A small amount of sub-fossil skeletal material from the floor of a limestone cave at Flowery Gully (see map) mostly mandibular and maxillary fragments, was determined as this species by Mr. J. A. Mahoney. This material is held in the collections of the Queen Victoria Museum.

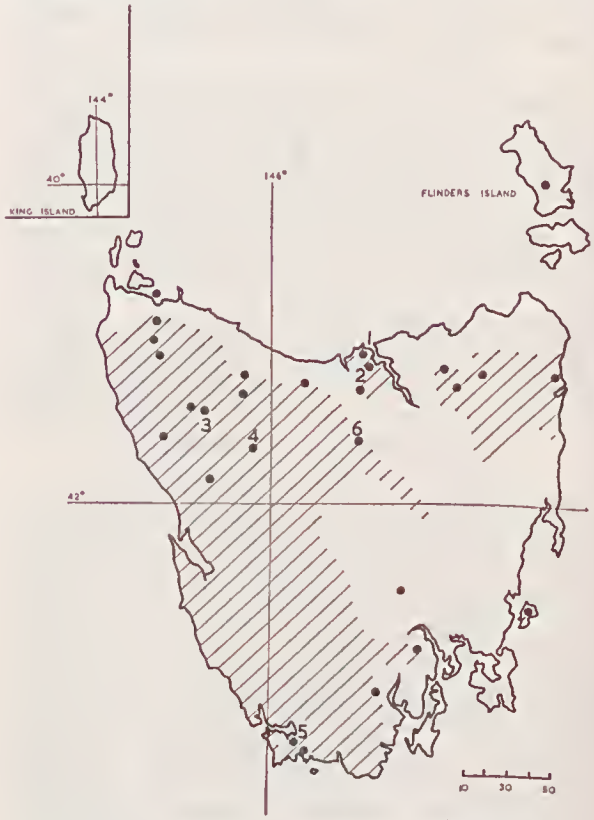

Figure 1. Localities from which *R. l. velutinus* has been collected and the probable overall distribution based on available habitat. Places mentioned in the text are: 1. Greens Beach. 2. Flowery Gully. 3. Waratah. 4. Cradle Mountain. 5. Port Davey. 6. Great Western Tiers.

HABITAT

R. l. velutinus commonly occurs in three distinct habitat types with a gradual decrease in numbers in marginal areas. In order of decreasing importance the principal habitat types are the Myrtle-predominant temperate rain forest, the Button grass sedgelands, and the coastal swamp lands. The marginal areas include

eucalypt forests, belts of poa tussock, tea-tree and heath-land and other suitable vegetation occurring as an ecotone.

The rain forests occupy extensive areas in the western half of the island and range in altitude from sea level to 3,500 feet (Jackson 1965). This habitat also occurs in the north-eastern highlands and on the steep slopes of the Great Western Tiers. These areas are subjected to widely differing extremes of temperature. In the winter months of April to September the more elevated areas are often covered with up to a foot of snow for several weeks at a time and temperatures might fall to 10°F. In mid summer this same habitat might experience extreme high temperatures, up to the mid nineties. Mean annual rainfall varies greatly and may exceed 100 inches in parts of the western highlands but in nearby similar habitat in the north-east, south, and on the Great Western Tiers, it may be as little as 40 inches (Langford 1965).

The forest canopy is a complex association of *Nothofagus cunninghamii* (Beech), *Atherosperma moschatum* (Sassafras), *Eucryphia lucida* (Leatherwood), *Phyllocladus rhomboidalis* (Celery-top pine), *Anodopetalum biglandulosum* (Horizontal scrub), and *Eucalyptus* spp. which vary in density and relative abundance according to soil, aspect and fire influence (Jackson 1965). Similar variations occur in the understorey which includes *Olcria argyrophylla* (Musk), *Pittosporum bicolor* (Cheesewood, Tallow-wood), *Drimys lanceolata* (Native pepper), *Persoonia gunnii* (Gunn's persoonia), *Anopterus glandulosa* (Laurel), *Dicksonia antarctica* (Soft tree-fern). The forest floor is heavily-littered with decaying debris and rotting logs and stumps, over most of which a carpet of damp green moss grows.

The sedgelands (see plates 1 and 2) occur principally in the western half of Tasmania and have a mosaic-like distribution as openings in the rain forest. They are associated with high rainfall and are subject to similar climatic conditions as the former habitat type. The dominant plant species is *Mesomelaena sphaerocephala* (Button grass) which is interspersed with *Restio australis* (Mountain cord-rush) and *Lepidosperma filiforme* (Common rapier-sedge). *Imperata cylindrica* (Bladey grass) and *Poa caespitosa* (Tussock grass) occur as isolated patches. A narrow ecotone of wet scrub includes *Sprengelia incarnata* (Swamp heath), *Epacris gunnii* (Gunn's heath), *Boronia rhomboidea* (Diamond boronia), *Baeckea gunniana* (Shrubby heath-myrtle), *Monotoea* sp. (Broom-heath), *Leptospermum* sp. (Tea-tree), *Oxylobium ellipticum*, *Gleichenia alpina* (Dwarf coral-fern) and stunted *Eucalyptus gunnii* (Gums). Sphagnum moss is plentiful in the wet and swampy areas and in some instances occurs as bogs up to several feet in depth.

Coastal swampland habitat is less extensive than the previous types and occupation by rats is restricted to suitable areas on the north and east coast which are not unduly affected by grazing. Colonies in these areas are usually numerically strong and often extend to dry elevated banks some distance away. The swamps may be partly or completely dry for several months during summer thus enabling the rats to form runways beneath the vegetation, but as they fill with the autumn rains the rats apparently withdraw to the drier banks.

The soil is mostly light and sandy and the vegetation typically coastal. The major swamps are usually surrounded by dense stands of *Melaleuca ericifolia* (Tea-tree) while the adjacent low-lying and gently sloping areas support an abundance of Tea-trees including *Melaleuca ericifolia*, *M. squarrosa* and *Leptospermum scoparium*. Heaths include *Epacris lanuginosa*, *E. impressa*, *Sprengelia incarnata* and *Leucopogon virgatus*. *Acacia verticillata* (Swamp wattle), stunted *Banksia marginata* (Honeysuckle), *Casuarina distyla* (She-oak), *Dianella tasmanica* (Rush lily) and *Lepidosperma filiforme* (Common rapier-sedge) are also numerous. This complex vegetation grows very densely and in the parts not subjected to recent burning may exceed six feet in height. On the more elevated areas its density decreases and it is partly replaced by *Pteris aquilina* (Bracken fern) with an over storey of *Eucalyptus* spp., *Casuarina strieta* and *Banksia marginata*.

R. l. velutinus occurs prolifically throughout these three habitat types and to a lesser degree in the ecotone, provided fire or over-grazing by domestic stock has not destroyed the vegetational cover. When this occurs recovery is slow and it may be many years before regrowth and ground cover is sufficient to allow repopulation. Habitat destruction by fire is believed to be the major factor limiting the population of *R. l. velutinus* but it must also be borne in mind that firing has always influenced the ecology and is less extensive since the extinction of the aborigines (Jackson 1965).

DESCRIPTION

The description is based on a series of 207 skins and associated skulls and 28 spirit specimens held in the Queen Victoria Museum. They have been assembled in the course of field studies conducted in 1963, 1964 and 1965 and were collected in a wide range of habitat types.

External characters

In general form (see plate 3) the rat is stout and appears to have little if any neck. The ears are rounded, appearing almost naked, and are greyish-brown in colour. The face is somewhat pointed with the eyes small and set well forward in the head. The iris is deep brown and the pupil black. The naked nostrils are pale flesh pink. The incisors are yellow on the anterior surface and chisel pointed, the lower set being long and slender and erupting to 10 mm. from the gums. The legs are short and the feet stout and sparsely covered with short hair. The claws are strong and usually clear though slight pigmentation may sometimes be noticed beneath the semi-transparent surface. The under surface of the feet is variable but the manus is always paler than the pes. The manus is generally white but in odd individuals it is slightly mottled with grey. The pads of the manus are rounded and smooth, the interdigitals being approximately equal in size. The metacarpals are much larger and more prominent with the outer slightly exceeding the inner in size. The digital formula is 3> 4> 2> 5> 1, the first being greatly reduced and rudimentary. There are four digital rings beneath each toe but the basal rings of the second and fifth digits are usually less distinct.

The pes is generally a dark leaden grey. The pads and digital rings are paler and in some instances almost white. The pads are prominent and vary in size and shape. The inner metatarsal is the largest, the outer metatarsal the smallest, with the digitals being approximately equal and falling between these extremes. The digital formula is 3> 4> 2> 5> 1. There are two digital rings beneath the first toe and five beneath each of the remaining toes, though the basal ring on the fifth toe is less distinct. The hind feet are turned gently inward and the rat is inclined to walk on the outer edge of the pes and toes, which gives a slightly distorted, pigeon-footed appearance.

The tail is shorter than the head and body, stout

and gently tapered. Tail scales are of a leaden grey colour and arranged in about 130 irregular rings which contain up to 20 scales each in the basal region and declining to about 10 in the distal region. The tail is sparsely covered with bristle-like hairs which occur in sets of three, except near the extreme tip where they are reduced to sets of two or singles. They are directed acutely to the distal end and arranged in line between the rings with a set erupting from behind each scale. They are dark brown at the base but paler towards the tip. Length varies to 1 mm. but the central member is the longest in each set.

Nipples are not easily discernable in sub-adults but mature females have invariably been found to have a formula of $2 + 2 = 8$ (see figure 2). This is in contrast to the mainland form which possesses an extra abdominal pair (Wood Jones 1923).

The scrotum become prominent as breeding approaches and may attain a length of up to 35 mm. and a width of up to 25 mm. It is well furred except for the posterior region which is naked and darkly pigmented. This scrotal pigmentation is evident from birth and is useful in determining sex when other external features are undeveloped.

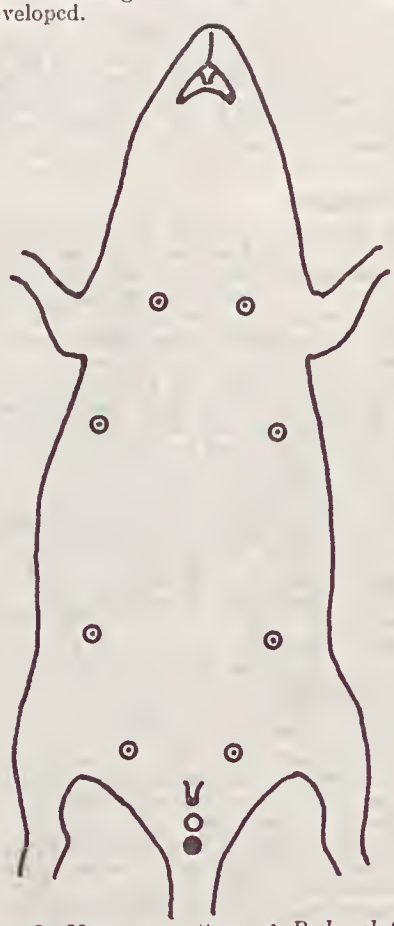

Figure 2. Mammary pattern of *R. l. velutinus*

Plastic dimensions

Plastic measurements were taken as follows :

Total length: From the tip of the nose to the tail tip, measured dorsally with the animal on its back.

Tail: From the base of the tail to the tip, measured dorsally with the tail turned up at right angles to the back.

Ear: From the tragoid notch to the ear tip.

Pes: From the back of the heel to the extremity of the longest (third) toe, excluding the claw.

As the breeding season extends over several months it is usual to find a considerable variation in the dimensions of individuals collected at any one time. In the summer and autumn months when the new season's young become independent they may be trapped along with adults and an overlapping of generations occurs. Table 1 has been arranged to show the weights and basic measurements of progressively aging rats. The data given bimonthly commences with new season sub-adults and carries through to the post-breeding adults. Though the samples given are small it is clear that in rats of equal age males generally exceed females in weight and size. A weight loss following mating is indicated in the males. The heaviest male weighed 159 gm. and was taken on 16.II.1965 from a Tea-tree swamp on the east coast. The heaviest female weighed 158 gm. and was taken on 8.II.1965 from west coast rain forest. She carried six half developed embryos. The relation of body weight to size varies considerably, especially in breeding and post-breeding rats. The largest male collected had a total length of 319 mm. (tail 151 mm.) but its body weight was only 131 gm. It was taken from western rain forest country on 7.II.1965 and was probably in the post-breeding decline. The largest female had a total length of 294 mm. and was the rat quoted above as being of greatest weight.

A comparison of the highland rain forest and coastal swamp land populations showed no significant differences. No sexual dimorphism is indicated in the relative proportion of tail, ear and pes when expressed as a percentage of head and body length.

Pelage

No sexual dimorphism in pelage characteristics could be detected. The fur is soft and dense. It is longest on the top of the rump where it attains a length of up to 20 mm. but decreases to 15 mm. on the shoulder region and flanks and to 10 mm. on the belly. It is a soft leaden grey for the greater part of its length and is slightly paler on the belly. The extreme terminal region is usually a sandy-yellow but this is variable and may be reduced, completely absent, or tipped with black. This creates different composite effects and accounts for the variation in superficial appearance which ranges from tan brown to blackish brown.

The length and density of the guard hairs varies considerably between individuals and this also creates a difference in the composite effect. They are longest in the region of the top of the rump where they may attain a length of up to 50 mm. On the anterior regions and flanks they are shorter and less prominent, and on the belly barely exceed the length of the main pile. They are coarse, and taper to a very fine tip and are a lustrous black except on the belly where they are pale sandy yellow. Pelage colour on the head is similar to that on the body except in the region of the lips where it fades to a soft grey.

Vibrissae are prominent and gently taper over their entire length to a very fine tip. They are generally black though some of the mystacials are pale terminally. Wear and breaking often account for a reduction in the number visible. The mystacials are arranged in five rows, the posterior members being the longest and

TABLE 1. Weights (gm.) and measurements (mm.) of *R. l. velutinus* arranged in progressive age groups of bimonthly intervals. Quotations are for extremes, with mean in brackets, of rats collected only in the month stated, but they have been assembled over the three year period from all types of habitat.

MONTH	SEX	NUMBER IN SAMPLE	WEIGHT	TOTAL LENGTH	TAIL	EAR	PES
Feb.	♂	8	33 - 74 (53.1)	182 - 235 (218.7)	74 - 113 (89.2)	18 - 20 (19.1)	24 - 29 (26.5)
	♀	6	19 - 77 (50.5)	164 - 225 (197.0)	74 - 98 (86.2)	16 - 20 (18.6)	20 - 28 (25.2)
Apr.	♂	13	43 - 104 (77.8)	202 - 270 (240.5)	84 - 115 (100.5)	18 - 21 (20.1)	25 - 30 (28.6)
	♀	5	44 - 82 (62.4)	185 - 254 (221.2)	79 - 120 (97.8)	19 - 20 (19.4)	24 - 28 (26.8)
June	♂	13	60 - 102 (78.4)	207 - 285 (246.2)	91 - 120 (108.9)	19 - 22 (20.2)	26 - 30 (28.4)
	♀	21	52 - 98 (70.5)	219 - 262 (240.0)	94 - 115 (104.3)	19 - 20 (19.7)	24 - 29 (27.9)
Aug.	♂	11	81 - 118 (94.1)	205 - 278 (255.3)	106 - 121 (112.7)	19 - 22 (20.2)	27 - 30 (29.1)
	♀	8	70 - 115 (94.9)	245 - 277 (257.0)	106 - 117 (113.0)	19 - 23 (20.9)	28 - 30 (29.0)
Oct.	♂	5	129 - 149 (139.4)	259 - 298 (280.4)	104 - 131 (117.2)	21 - 22 (21.4)	29 - 31 (30.2)
	♀	5	87 - 114 (105.2)	246 - 265 (253.6)	95 - 110 (103.2)	18 - 21 (19.9)	25 - 30 (27.4)
Dec.	♂	4	118 - 150 (129.5)	268 - 290 (280.0)	110 - 126 (118.0)	20 - 21 (20.7)	29 - 31 (30.0)
	♀	3	75 - 112 (97.5)	254 - 263 (260.0)	103 - 116 (110.0)	20 - 22 (21.0)	29 - 30 (29.0)
Feb.	♂	25	93 - 145 (114.8)	265 - 319 (282.7)	108 - 151 (126.1)	19 - 22 (20.5)	28 - 31 (29.4)
	♀	25	70 - 158 (114.3)	260 - 294 (278.2)	114 - 129 (122.4)	20 - 22 (20.6)	27 - 30 (28.8)

attaining a length of up to 55 mm. They progressively decrease in length and diameter towards the nose, the most anterior reaching to about 10 mm. The upper two rows generally consist of four vibrissae each, the central, five, and the lower two rows, six each. Up to three supraorbitals may be present ranging to 36 mm. in length with the posterior the longest.

Genal vibrissae are not easily discernible but one or two up to 30 mm. long may be present. Interramals are very fine and indistinct, with normally three in the set reaching to 14 mm. Three ulnar carpal vibrissae are normally present and reach to 11 mm.

Skull

The measurements given in table 2 were taken from a series of 60 skulls of rats collected during the summer months from all habitat types. All carried tooth wear indicative of mature animals, probably in excess of one year old. Most skulls had been cleaned by dermestid beetles. Measurements (see figure 3) were made with slide calipers graduated to one tenth of a millimeter. No sexual dimorphism is indicated in the skull proportions.

Molar tooth wear increases with age (see plate 5) and is well illustrated in the skull series when arranged in the order of monthly catches. Because breeding in the wild state is restricted to an annual season, rats taken in any one month can be grouped into an approximate age category by the degree of molar wear. Two easily separable groups can be determined: those in their first year and those in their second year. Odd individuals with exceptionally heavy molar wear sometimes occur and can be separated from the second year rats. These are thought to be those which sometimes survive into the third year. This has been found to occur occasionally in cage studies and in tagging studies of wild rats.

The three age groups are shown in table 3 and the catches for each month over 3 successive years are given for males and females. Though the sample is small some indication of the seasonal variation in population structure can be deduced. Trapping in February produced a total of 67 rats, the sexes being about equal but the new season's young, with teeth barely worn,

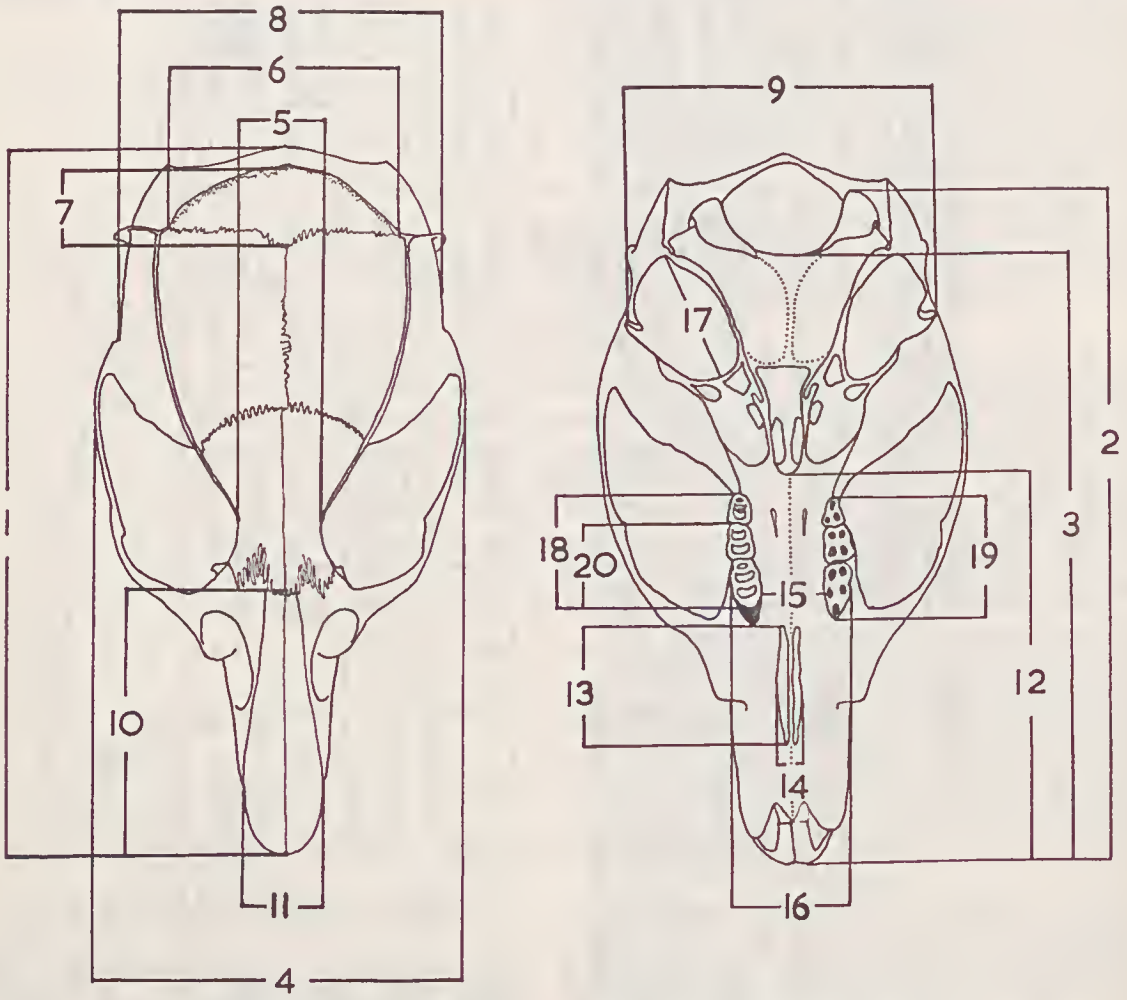

Figure 3. Points from which the skull measurements mentioned in the text were taken.

were very much in the minority. Of the 55 adults, 5 females and 1 male had exceptionally heavy tooth wear and were presumably old rats which had survived two breeding seasons and were into their third year.

In comparison, trapping in June showed a completely different population structure. Rats in their first year were very much in the majority and though many post breeding females, then in their second year, were still surviving, no second year males were caught. By November-December the populations consist primarily of rats approaching the end of their first year with the sexes in about equal proportions.

No rats have been found with abnormal dental development or decay. The length of the upper incisors was variable in the older rats, in some instances differing by as much as 30% between individuals of otherwise

TABLE 2. Comparisons (mm.) of skull measurements of males and females of adult *R. l. velutinus.*

	30 Males		30 Females	
	RANGE	MEAN	RANGE	MEAN
1. Total length	35.5 - 40.5	37.91	36.7 - 40.0	37.87
2. Condylo-basal length	34.5 - 39.0	36.55	35.5 - 38.8	36.65
3. Basal length	32.3 - 36.5	34.22	33.5 - 36.4	34.32
4. Zygomatic width	19.1 - 21.3	20.17	19.4 - 21.3	20.31
5. Inter-orbital width	5.4 - 6.3	5.85	5.4 - 6.1	5.84
6. Inter-parietal length	3.3 - 4.4	3.98	3.4 - 5.0	4.09
7. Inter-parietal width	8.0 - 11.0	9.55	8.0 - 11.3	9.79
8. Cranium width	15.7 - 17.5	16.47	15.8 - 17.4	16.46
9. Mastoid width	15.6 - 17.1	16.35	15.3 - 17.3	16.34
10. Nasal length	13.3 - 15.6	14.19	13.1 - 14.7	14.20
11. Nasal width	3.5 - 4.4	3.99	3.7 - 4.6	4.05
12. Palatal length	19.2 - 21.9	20.61	20.2 - 21.6	20.78
13. Palatal foramin length	5.9 - 7.3	6.67	6.1 - 7.4	6.80
14. Palatal foramin width	1.4 - 1.7	1.52	1.3 - 1.9	1.51
15. Width inside M^1-M^1	2.8 - 4.1	3.33	2.8 - 4.4	3.24
16. Width outside M^1-M^1	7.7 - 8.9	8.24	7.8 - 9.5	8.22
17. Bulla length	5.7 - 6.7	6.29	5.7 - 6.6	6.21
18. Length crowns M^1-M^3	6.1 - 6.9	6.50	6.0 - 7.4	6.52
19. Length alveoli M^1-M^3	6.8 - 7.7	7.20	6.5 - 7.8	7.23
20. Length crown M^1-M^2	4.3 - 5.0	4.64	4.1 - 5.1	4.61

TABLE 3. Number of rats in each age group in the month they were collected over the three year period. Classification is based on the degree of molar tooth wear.

	Age groups of females			Age groups of males		
Month	1st Year	2nd Year	3rd Year	1st Year	2nd Year	3rd Year
J.	0	0	1	0	1	0
F.	5	25	5	7	24	1
M.	2	1	1	0	0	0
A.	5	1	1	12	3	0
M.	3	1	0	4	1	0
J.	20	15	0	12	0	0
J.	1	0	0	2	0	0
A.	5	2	0	11	0	0
S.	0	0	0	2	0	0
O.	3	2	0	5	0	0
N.	5	0	0	5	0	0
D.	4	0	0	4	0	0

approximately equal proportions. Such differences appeared to be caused by lack of wear and subsequent over growth.

HABITS

R. lutreolus has been described as a water loving species and Wood Jones (1923) states that it spends much of its time in the water. Gould (1863) illustrates it swimming. Observations indicate that this is not necessarily the case with the Tasmanian subspecies as much of its preferred habitat has been found to be in steep and well-drained areas. Often its only association with free water is during or immediately after rain. Under swampy conditions its runways are wet and muddy but it shows no desire to avoid them. If the living area becomes covered with water the rats evacuate it in favour of more elevated ground. In some instances runways leading from dry ground have been found to traverse the top of dense vegetation growing in several feet of water. On two occasions rats of the species (or possibly the broad-toothed rat *Mastacomys fuscus*) have been flushed from creekside growth and have jumped into the stream, swum on the surface to the other side and disappeared on another runway. Though it apparently has no objection to wet or muddy conditions under foot and will take to water if circumstances necessitate, it prefers to keep its body fur dry and avoids swimming when possible. Stomach contents do not suggest that it takes food from the water.

Runways and burrows

The structure of runways varies between the different habitat types. In the coastal swampland and sedgeland habitats they are well developed and may form a labyrinth of tunnels, completely or partly concealed beneath the vegetation, and interlinked by well formed pads across the exposed intervening areas. The runways are about one and a half inches across and are formed by the rats chewing away everything which obstructs their path. Exposed woody roots and twigs are gnawed away and regrowth is kept well trimmed. Streams up to two or three feet wide are no barrier as runways have been found which terminate at the water's edge and start again on the opposite bank, the rats presumably jumping the intervening distance. Runways become less distinct as the suitability of the habitat decreases and appear to be used for access to feeding areas and to provide freedom of movement throughout the habitat. Clear well formed runways would also reduce fur soiling by lessening the contact between the animals and wet vegetation.

In the rain forest, runways are not nearly so common. Much of the forest floor is clear of vegetation which might impede the rats' movements and their formation is apparently unnecessary. Faint runways may sometimes be discernible beneath the sheltered edge of logs, or passing beneath rotting timber and upturned stumps; but even in the vicinity of entrances to well-used subterranean retreats they do not attain such prominence as in the swampland and sedgeland habitats.

Sub-surface burrowing is common in the light sandy soils of the coastal swamplands but sites chosen are usually on drier elevated ground and in a patch of dense Tea-tree or similar scrub. They range in extent from a single short burrow to elaborate warren-like excavations over an area of a hundred square yards. Burrows are from one and a half to two inches in diameter and may run in any direction, usually only a few inches beneath the surface. They are often branched, and excavated soil is deposited in a heap at the entrance. These soil heaps are conspicuous but the hole from which the soil was raked is often blocked up and an alternative opening used. Exit holes without spoil and well concealed amongst the debris provide the rats with emergency escapes. Dry grass, leaves and similar vegetation are carried into the tunnels for nesting material. Warrens are used indefinitely by succeeding generations but parts are sometimes abandoned and new sections may be excavated. Even the extensive warrens are occupied by only one family at a time comprising of an adult pair and their several litters of young.

Sub-surface retreats are also common in the rain forest habitat but rarely are these excavated by the rats. Many years accumulation of fallen timber, debris and moss have provided suitable cavities. Holes in rotting logs and stumps are also utilised. Debris and moss makes the entrances inconspicuous.

In the sedgeland habitat the surface burrows are almost completely absent presumably because of the unsuitability of the wet peaty soils. In much of this habitat, seepage would swamp such burrows particularly in the winter months. Their place is taken by tunnels formed in the base of dense Button grass clumps or similar vegetation. This provides for good drainage and elevates the nest sites above the wet ground. Despite much searching only a few such nests have been found in the wild state and these have all been empty. They were situated in the base of Button grass or Poa tussocks and were formed by the rats chewing away surplus material to create cavities about nine inches in diameter. The nest cavaties were heavily lined with dry vegetation apparently removed from the site and the nest chambers were about four inches in diameter.

Feeding and faeces

The diet of *R. l. velutinus* varies with the habitat and season but it is primarily vegetarian. In the coastal swampland and sedgeland habitats it consists of various fine rushes, grass stems and the succulent roots of Button grass. Clumps of Button grass have often been found with the root system almost completely eaten away and beneath the dead or dying plant lies a mixture of loose earth and rejected fibrous root material. In the summer months the new shoots of Button grass are bitten off, husked and eaten. In the rain forests this food source if not available and the rat presumably turns to seeds and other plant foods. The stomachs of rats from rain forest habitat have been found to contain also small amounts of insect material. A sample of six rats collected from a gully in the Great Western Tiers on 9.XI.1965 was found to have been feeding almost entirely on various insect larvae. This was exceptional and is the only instance encountered when the stomach contents of this rat have not consisted primarily of vegetable matter.

Wood Jones (1923) states *R. lutreolus* "will invade the camps of duck shooters in the usual rat fashion". Presumably this refers to tent dwellings. The Tasmanian subspecies rarely if ever invades houses or bush huts. In the Cradle Mountain — Lake St. Clare Reserve in the Tasmanian central highlands there are a number of old shingle huts which provide accommodation for visitors and walking parties. Most are sited in the shelter of forests and are in the midst of good populations of *R. l. velutinus*. They are often invaded by other rodent species scavenging for food but I have never known *R. l. velutinus* to offend in this way.

Cage studies (see later) have shown that *R. l. velutinus* will drink liberally when water is available but is capable of existing for long periods without drink-

Plate 1. Sedgeland habitat near Cradle Mountain. Normal summer conditions.

Plate 2. Sedgeland habitat near Cradle Mountain under two feet of winter snow. July, 1966.

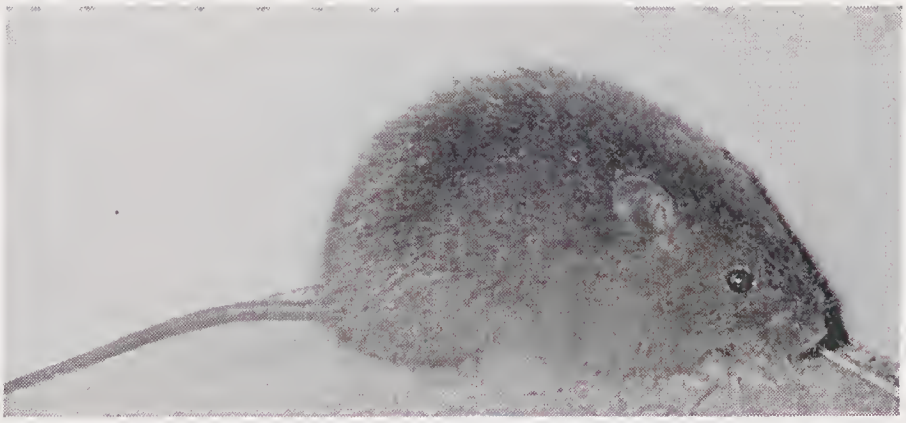

Plate 3. Adult *R. l. velutinus.*

Plate 4. Skull of *R. l. velutinus.*

Plate 5. Molar tooth wear in *R. l. velutinus* at about 3 months, 12 months and 24 months respectively.

Plate 6. *R. l. velutinus* one day old.

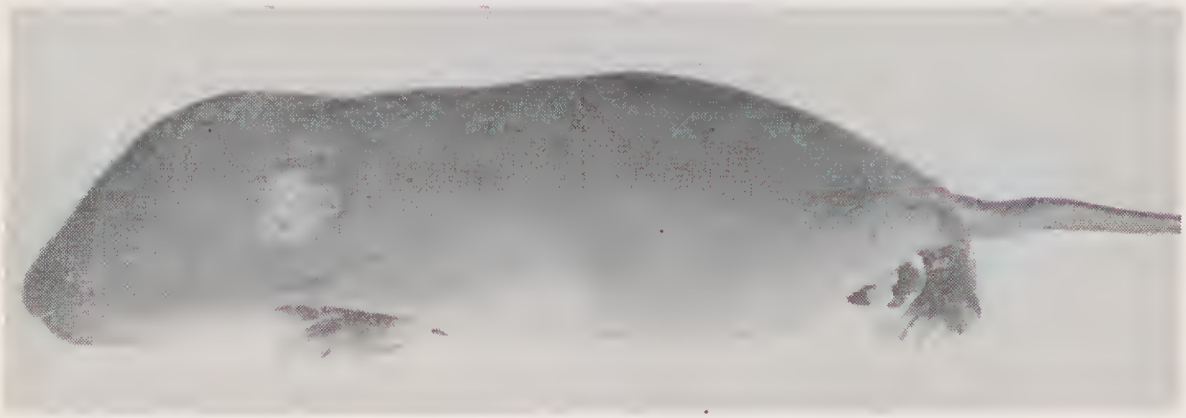

Plate 7. *R. l. velutinus* 12 days old.

ing provided it can obtain reasonably juicy vegetable foods. There are extensive areas in all habitat types where populations are without free water, particularly during the summer months. Here they must survive on the moisture obtained from their food or precipitation licked from the foliage.

R. l. velutinus defaecates and urinates indiscriminately and the number and condition of faecal pellets can indicate the numerical strength of a population. Pellets are generally scattered along the runways and over feeding areas and when fresh can usually be distinguished from those of other native mammals by size, colour and composition. Those species most likely to cause confusion are *M. fuscus, P. higginsi* and *Antechinus* spp. The faecal pellets of *R. l. velutinus* are generally a uniform elongated oval shape 12 mm. to 15 mm. in length and 4 mm. to 5 mm. in diameter but may be of lesser proportions if of sub-adults. They vary from grey to brown in colour and are of a coarse composition. Faeces of *M. fuscus* are easily separable on colour as they are a bright green, those of *P. higginsi* differ in being composed of more finely comminuted material, and those of *Antechinus* spp. are characteristically composed of insect remains.

BREEDING

In the wild

Young males do not usually show any scrotal development until early spring and the approach of the breeding season. During the non-breeding period in winter testes are carried inguinally and range mostly from 6 x 4 mm. to 15 x 9 mm. depending on the rat's age. From August the testes drop into the scrotum which becomes large and conspicuous. They may then measure up to 25 x 15 mm. Testes contraction and retraction take place after the breeding season.

Young may be produced from October to February and both pregnant and lactating females have been trapped over this period. Populations in the colder highland habitats do not generally commence breeding as early as those in the warmer coastal areas. Litter size has been found to range from three to six and the embryos may develop in both horns of the uterus in any numerical order (see table 4). More than one litter may be produced annually, and copulation may occur soon after parturition, as shown by captive studies.

Nipples are difficult to discern in the sub-adults but can be easily located after August with the approach of breeding. Nipple distension, as a result of suckling, is not obvious in early lactation but in the later stage it is apparent and nipples may be manually stretched to 8 mm. With care, milk can be expressed with the fingers. Fur loss, from the vicinity of the nipples, is usually slight but may increase with succeeding litters and become noticable towards the end of the breeding season.

In captivity

Attempts to breed *R. l. velutinus* in captivity in 1963-4 and 1964-5 were without success. The paired rats had been housed in wire fronted tin cages measuring 18 inches long by 10 inches deep and 12 inches high. Each cage was equipped with an exterior nesting compartment measuring 6 x 5 x 5 inches. The floors of the cage were liberally lined with saw dust and dry straw was provided for nesting material. A variety of food items including fruit, green vegetable leaves or lawn clippings, and commercial dog cubes was always available.

Nests were formed by the rats shredding the dry straw into fine strands and packing it in the nest boxes to form a dense lining and leaving just sufficient space for occupation.

A number of wild-caught unassociated individuals were paired under these conditions in the spring of 1963, and in 1964 the attempt was again repeated with the addition of a pair reasonably assumed to have been paired in their wild state. Attempted copulation was noticed on one evening but no young were produced.

In February 1965, while collecting in the Waratah area, eleven adult females were collected alive, indivually housed in the cages described, and taken home for breeding studies. Of the adult females killed and processed on this collecting trip about 60% were pregnant and it was considered reasonable to assume that about half the live sample would be in a similar condition. After five weeks in captivity, during which time none had been found to produce young and no abdominal distension was noticable, the sample was killed and processed. None of the rats were found to be pregnant but small scar-like marks were noticeable in most uteri. It was then assumed that resorption of the embryos had taken place as a result of shock, caused by the sudden environmental change.

On 8.XI.1965 a sample was collected from the Great Western Tier. One female, reasonably assumed by palpation to be pregnant, and a pair trapped from a

TABLE 4. Analysis of eleven sets of embryos from wild-caught *R. l. velutinus*.

Date	No. of Embryo	Uterine Horn	
		Left	Right
13.X.1963	4	?	?
23.II.1964	4	1	3
24.II.1964	4	1	3
8.II.1965	5	1	4
8.II.1965	6	2	4
11.II.1965	3	2	1
11.II.1965	3	1	2
9.XI.1965	3	2	1
19.XI.1965	5	5	0
6.XII.1965	4	3	1
6.XII.1965	4	1	3

common burrow, were retained for further cage breeding attempts. The single female was housed as previously described and after eight days in captivity showed no further abdominal distension, nor could any indication of embryos be felt by palpation. She was then killed and processed and was found to contain two almost resorbed embryos, one in each uterine horn, appearing as dark lumps about 4 x 2 mm. each. The uterus was preserved and added to the Queen Victoria Museum collections (Reg. No. 1965:1:256).

The remaining pair was housed in a larger cage measuring 8 feet long by 30 inches deep and 30 inches high. On one end was a closed-in wooden box measuring 18 x 10 x 12 inches inside which was a smaller nest box measuring 6 x 5 x 5 inches internally. Dry straw was provided for nesting material and on the first night of housing the rats lined and occupied the small nest box. Though no abdominal distension was noticeable pregnancy was suspected as other females taken on the same collecting trip were found to be pregnant. Periodic inspections of the nest box were made. It was invariably found to be occupied by both rats during the day time and at night they shyly entered the cage area to feed, drink, and exercise. If disturbed during these excursions they hurriedly retreated to the shelter of the nest. Very little attempt was made to escape by gnawing.

At 0800 hours on 18.XI.1965 faint squeaks could be heard coming from the nest box and upon examination the female flushed from the nest which was then found to contain four newly born young. The male was hiding beneath straw near the nest. Though timid the female made several attempts to re-enter the nest box before retiring to the other end of the cage. One young was then removed and taken away for examination and five minutes later when the nest box was again examined the remaining three young were found dead on the floor outside the entrance to the nest. Each had been bitten about the head and thoracic region and one had the top of the head and brains removed (see plate 6). The male was discovered inside the nest box in a highly excited condition and was apparently responsible for the havoc. The female still remained at the other end of the cage.

The male was then removed from the cage and placed in alternate housing. The remaining young was returned to the nest and the female quietly roused till she re-entered the nest. When examined half an hour later both animals were found resting quietly in the nest. On 24.XII.1965, at 35 days, the young was found to have abandoned the nest and was living in a hole formed in accumulated rubbish beneath the nest box. It had apparently formed the hole itself as there was not sufficient room to allow the female to enter.

On the 23.I.1966 the young was found in an advanced state of decomposition, the cause of death unknown. Its estimated life was 60 days. The male was then returned to the cage with the female but did not readily associate with her. Subsequent inspections were usually carried out when the rats fed and the male was rarely found in the nest box with the female. He had enlarged the chamber beneath the box and usually rested there.

About this time the rats gnawed several holes through the wooden walls of their cage and thus gained access to the main housing area which was a cage 15 feet long by 12 feet deep by 6 feet high. They were left undisturbed and shared the extended range with a family of *P. higginsi*. Much additional straw and litter was collected by the rats and carried to the nest box until it became completely covered and tunnels were formed in the accumulation.

On 7.III.1966 the female was found to have a second litter in the same nest. It consisted of three males and one female and based on growth and development rates of other litters (see later) the young were estimated to be between 9 and 12 days old. One male, Reg. No. 1966:1:18 was removed and preserved in 70% alcohol. This was 43 days after the adult male was presented to the female and gives and estimated gestation period of less than 31 days.

The 3 remaining young developed normally and by 26.III.1966, 2 had abandoned the nest. The following morning all 3 were missing and the nest was found to contain 5 newly born young.

On 3.IV.1966 one juvenile male was removed and preserved in 70% alcohol. (Reg. No. 1966:1:19). The remaining 4 were reared and abandoned the nest about 18.IV.1966 to live in the cavity beneath the nest box. Soon afterwards the nest box was found to have been completely cleaned out and left bare. Adjacent accumulated rubbish was also reduced and scattered some three feet away from the nest site. This activity destroyed the tunnels round the nest box and the newly weaned young of the third litter were found to have dispersed to other sleeping quarters, often in association with the second litter.

On 6.V.1966 the old female was found to have just produced a fourth litter of three in a new nest site. On this occasion it was in a nest box attached to a cage 5 feet above the ground which had up to that time been used as sleeping quarters by the family of *P. higginsi*. These were found to have moved to new quarters and the nest had been completely renovated with the addition of much new material. All three of the fourth litter were reared and abandoned the nest on 28.V.1966.

On 6.VII.1966 a nest containing a litter of four males, estimated to be about six or seven days old, was found in a nest box about four feet above the ground. The old female was present but quickly flushed when disturbed. The following morning the nest was found disarranged and the young discarded and partly eaten.

The breeding area was not examined again until 6.X.1966 when it was found that a litter of 3 estimated to be about 38 days of age, were present and had already abandoned their maternal nest.

On 9.X.1966 a nest of 4 young was found and these were estimated to be about 12 days old. On this occasion the parent female was found in the nest with the young and a male was in an associated nest built along side but partitioned from the maternal nest. As no other rats were in the immediate vicinity it was assumed that this male was the female's established mate and both were removed, together with the young, to a small tin cage (previously described) and kept indoors for closer observations. Upon examination the male was found to be a young of the third litter, born on 27.III.1966. It appeared to be in full breeding condition and had a body weight of 140 gm. All continued to live harmoniously in the confined space, the male often sharing the maternal nest. The four young were weaned and removed from the cage on 5.XI.1966 and the adult pair retained for further observations. The female was always alert and timid. The male was more sluggish and was often found asleep lying curled up on its side in the nest. It was, however, more spiteful than the female and would bite one's hand at every opportunity.

The original male and presumed sire of the first six litters appeared to be in a post breeding decline and was found dead on 18.XII.1966. Details of the litters are tabulated in table 5.

Throughout this breeding period the old male was never found to associate with the female or progeny in the nest. It alternated its choice of diurnal resting quarters between several sites but usually chose elevated positions up to 6 feet high. Access to these was gained by climbing the wire netting sides of the main housing area.

Both the adult males and the female appeared in a healthy condition throughout the breeding season but the female was usually more active.

TABLE 5. Nest periods of 7 litters of *R. l. velutinus.*

Litter No.	Date of Birth	Number in litter	Nest Abandonment
1	18.XI.1965	4	24.XII.1965
2	23-26.II.1966	4	26.III.1966
3	27.III.1966	5	18.IV.1966
4	6.V.1966	3	30.V.1966
5	29-30.VI.1966	4	Killed 7.VII.1966
6	28.VIII.1966	3	before 6.X.1966
7	28.IX.1966	4	5.XI.1966

DESCRIPTION, GROWTH AND DEVELOPMENT OF YOUNG

Description of newly born young

Newly born *R. l. velutinus* (see plate 6) are naked with a loose semi-transparent pink skin through which can be seen the outline of the ribs and intestines. The eyes are closed and appear only as dark marks. The ears are closed with the terminal half turned down and adhering firmly to the basal region so as to completely seal the aperture. The mouth is well formed and radiates 4 mm. from mid lip. No teeth have erupted and the gums are soft and jelly-like. The nostrils appear as small pin holes 2 mm. apart. Front and back feet are evenly developed with the claws erupted to 0.3 mm. and the pads well formed. The tail is proportionally short, being only about twice the pes length and with no signs of scalation. The facial region is robust with a swollen appearance and a few hairs, visible only by magnification, are present on the lips and chin. Vibrissae are erupting with mystacials to 1.5 mm. and supraorbitals and genals to 1 mm. The weight and measurements of the three young illustrated in plate 7 are given in table 6.

When newly born they are slow of movement and possess little control of their position in the nest. Vocal powers are feeble but are exercised when the young are disturbed by the movements of the parent. Sex is determinable by a slight grey pigmentation of the skin in the scrotal region of males. This pigmentation is lacking in the females. Finlayson (1960) found the males of *Rattus greyi* recognisable by this feature at 12 days old. Taylor (1961) found the same feature recognisable in *R. assimilis* at 2 days old.

Growth and development

The progressive growth and development has been found to vary considerably between litters, some developing much faster than others. Following weaning, the males of the litter usually developed more rapidly than did the females.

Growth and development of the only surviving young of the first litter was very slow and at the time of its death at about 60 days it had attained a body weight of only about a third and a total length of about half of that of subsequent litters at the same age. This was, in part, due to the loss of its left front leg from an unknown cause at about 15 days of age. However, development was slow from the time of birth and this may have been due to poor lactation consequent on the lack of stimulus provided by the single young. In the subsequent litters it was found that the numerically largest litters grew and developed at the fastest rate. But for a slight slackening at about 25 days, or about weaning time, the rate of growth and development established during the suckling period was carried through to near maturity. The growth and development of the three normal litters was fairly constant, but there was some variation.

TABLE 6. Weights (gm.) and length (mm.) of three of the first litter of *R. l. velutinus* at less than one day old.

	♂	♂	♀
Weight	4.89	5.34	4.14
Total length	63	65	64
Tail length	14	14	14
Head length	18	18	BROKEN
Pes length	8	8.5	7.5

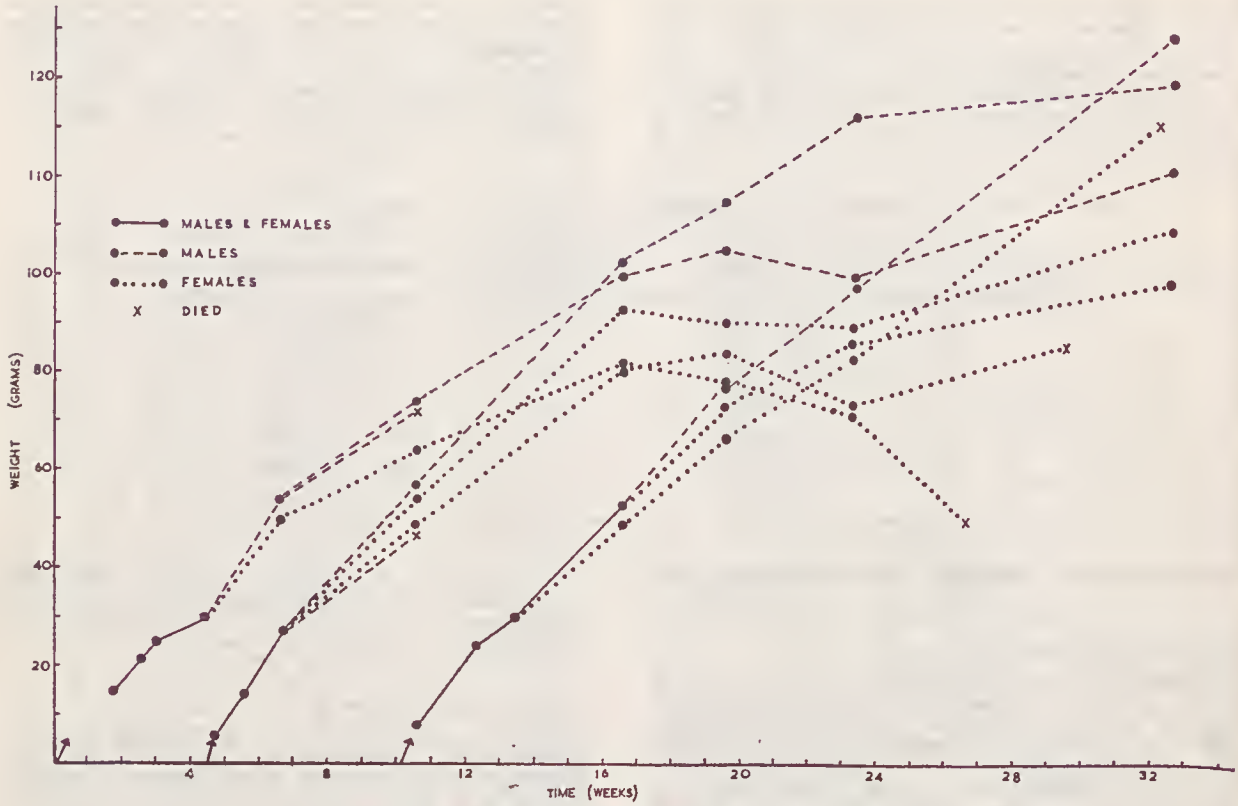

Figure 4. Weight gain in three litters of *R. l. velutinus.*

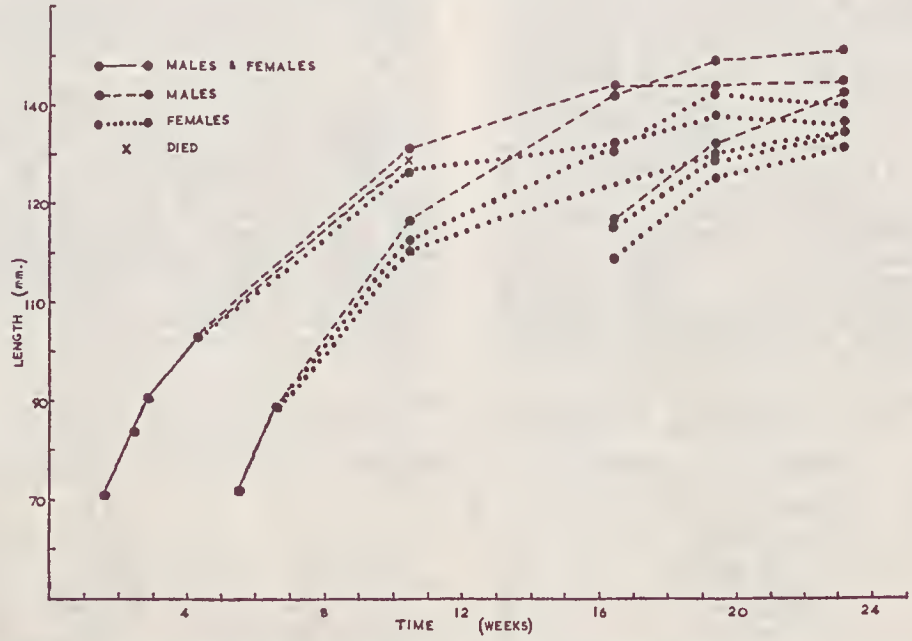

Figure 5. Growth rate of the head and body in the three surviving litters of *R. l. velutinus.*

Weights and body lengths are shown in figures 4 and 5.

A female of the fourth litter was accidentally killed on 6.X.1966 when 154 days old. Upon dissection she was found to be carrying 3 partly developed embryos in the left uterus. Her pregnant condition no doubt was responsible for the rapid weight gain illustrated in figure 4.

At 3 days the young appeared noticeably fatter than at birth and their skin had lost its loose, wrinkled appearance. The dorsum had become greyish.

At 7 days they were still sleepy and listless but would readily squeak if handled. The milk-filled intestines were still visible through the abdominal skin. The eyes remained closed but the lids were clearly formed. In one individual the ears opened and the terminal half became erect but in most cases this development took place several days later.

Pelage had erupted all over the body and was clearly visible to the naked eye as a fine fuzz, though less so on the ventrum. On the dorsal surface it was black, the body fur reached to 0.3 mm. and the guard hairs to 1 mm. The dorsal skin was grey and the ventral skin and erupting pelage white.

The skin of the tail was grey except for the extreme tip which was still white. The tail scales were clearly visible, the central hair of each scale being black and reaching to 0.5 mm. on the basal half but becoming progressively shorter terminally.

The dorsal skin on the feet was grey with black hairs just erupting. The soles of the feet were pale grey to white, the manus being paler than the pes. A few vibrassae were present and reached to 2 mm.

The region of the lips and nose was still relatively large. Five rows of white mystacial vibrassae were clearly visible, the posterior being longest and reaching to 9 mm.

At 12 days (see plate 7) the young were active, crawled confidently and would quickly regain their feet if placed on their back. They readily nuzzled into holes such as the half closed fist and having found seclusion would rest quietly in any position.

Dorsal fur reached to 2 mm. with the guard hairs to 4 mm. and mystacial vibrissae to 12 mm. The incisor teeth were clearly visible through the gums, the lower pair being slightly more prominent. The ears were still thick and lacked controlled movement. Odd fleas and mites were present in the short pelage and the young rats occasionally scratched their head, neck and scapular region with the hind foot.

At 16 days they responded to noise and would endeavour to escape when handled. After handling they were often seen to "wash" the facial regions with the front paws. The ears were well developed and actively used as were the nose and mystacial vibrissae. On the mid dorsal region the body fur reached to 4 mm. with the guard hairs to 5 mm. The ventral pelage was somewhat shorter and had developed to a pale grey. The mystacial vibrissae reached to 18 mm. and the eyes were opening. The incisor teeth were clearing the gums and had a yellow facing but the extreme tips were white. Finlayson (1960) found the suckling young of *R. greyi* to have their incisor teeth also tipped white.

At 22 days they were very alert and active and would explode from the nest when disturbed. From about this age they abandoned the maternal nest and lived by day in any nearby hole or nest box which was available, often in company with others of previous litters. They would bite when handled but were hardly strong enough to break the skin of the hand. The white tips had worn from the incisors. Pelage was adult-like in appearance with the body fur on the mid dorsal region reaching to 10 mm. and the guard hairs to 17 mm. Mystacial vibrissae reached to 30 mm. The vaginas of the females were open.

From about this age they appeared to be weaned onto a solid diet and to live an independent life. Except for their smaller size they were adult in appearance.

TRAPPING AND FIELD STUDIES

Trapping

The common household snap trap was used as the principal means of collecting when rats were wanted for dissection or processing. When collecting for live studies 9 x 3 x 3 inches Sherman box traps were used. These had been made from galvanised flat iron and were more robust than the standard aluminium type which can be chewed and distorted by the rats (Pers. comm. B. E. Horner).

A variety of baits was used including rolled oats, peanut butter, honey, raisins and chopped bacon mixed in various proportions. Apple, cheese, bacon, raisins, raw meat, plain bread and bread scented with vanilla essence were used individually. Catches were made on all kinds of bait but no marked preference was shown for any one. Consequently plain bread cut in three quarter inch cubes was used for preference because of the convenience of handling and the absence of messiness often resulting from the use of other baits.

Skull damage caused by snap traps occurred in about 10% of catches. Predation on trapped rats was rare, and in the few instances damage was confined to the thoracic region and of such a nature as might be expected from *Antechinus* spp.

No interference was encountered from Quolls *Dasyurus viverrinus* as was experienced by Finlayson (1933), even in areas near to Cradle Mountain where he found it necessary to remove the local Quolls before being able to collect rats satisfactorily.

Traps were generally set at intervals of ten to twenty yards depending on the indications of relative abundance. Preferred sites were on runways but many catches were made beneath logs, bush and general foliage. A total of 245 *R. l. velutinus* has been captured in about 4,000 trap nights. An additional 1,700 trap nights for tagging and release studies has resulted in 45 original captures and 150 recaptures. During these operations the total catch of other species of murids and phascogales, almost equalled that of *R. l. velutinus*. Under normal trapping conditions it was found that over half the resident population could be collected in the first 24 hours. When animals were being removed, sets were usually limited to this period; not only to enhance the trapping results but also as a safeguard against local extermination.

Trap checking carried out at different times of the day and night has shown that *R. l. velutinus* is diurnally active. Traps set out before mid-day have often produced an evening catch about equal to that of the following morning. On several occasions while setting out traps during the day, a trap just set has been heard to fire and upon examination found to contain a rat. In areas with reasonably high populations, with traps set at 10 yard intervals, a 24 hour catch of better than 10% would be expected throughout most of the year. During the earlier months of the breeding season, when populations are at their lowest numerical strength, the catch is usually somewhat less.

Field studies

The first field studies were started at Greens Beach in January, 1964. The area selected was a natural